

A taxonomic re-assessment of *Aedes* (*Ochlerotatus*) *caballus*
(Theobald) (Diptera: Culicidae) including a description of
a new species of *Ochlerotatus* *

by

B. M. McINTOSH

Arbovirus Research Unit, South African Institute for Medical Research, Johannesburg

Among what is currently known as *Aedes* (*Ochlerotatus*) *caballus* (Theobald) three species are recognised and described. These are *Aedes caballus* (Theobald) 1912, *Aedes chelli* (Edwards) 1915, (raised from synonymy), and *Aedes juppi* spec. nov. Keys for the identification of the adults of the six African species of *Ochlerotatus* are given.

As currently known, *Aedes caballus* (Theobald) is believed to be a mosquito of considerable economic importance in the temperate region of South Africa. It has been implicated as a vector of Rift Valley fever (Gear et al. 1955), Wesselsbron and Middelburg viruses (Kokernot et al. 1957, 1958, 1960) and it has been found naturally infected with West Nile virus (Arbovirus Unit, SAIMR, unpublished). However, uncertainty exists with regard to the taxonomic status of this species as it includes different morphological forms suggestive that it consists of a complex of species.

Grabhamia caballa was described in 1912 by Theobald from 12 females from Onderstepoort, South Africa. *Ochlerotatus chelli* was described in 1915 by Edwards from three females from Dido, Kenya. In 1924, Edwards in reference to mosquitoes collected in South West Africa described what he, (in my opinion, mistakenly) believed to be the male of *chelli*, under the name *Aedes* (*Ochlerotatus*) *chelli*. He later (Edwards, 1925) synonymized *chelli* with *caballa*, the latter then being referred to as *Aedes* (*Ochlerotatus*) *caballus*. In his review of Ethiopian mosquitoes, Edwards (1941) retained *chelli* as a synonym of *caballus* but drew attention to the existence of three morphological forms included in his definition of *caballus*, which he probably regarded as conspecific because of the similarity in their male genitalia. These forms differed in the pale scaling of the wings and in the pale bands of the tarsi. Muspratt (1955) also commented on variation in these structures among *caballus* from South Africa.

Recent examination of *caballus* specimens from South Africa convinced me that a taxonomic re-assessment of this species was required. With this in mind I have examined all *caballus* material at the South African Institute for Medical Research and the British Museum (Natural History) including the holotype of *caballus* and the syntypes of *chelli*. From females of the two forms occurring in South Africa, several rearings have also been made in isolation. As a result I am recognizing three species from among what was previously regarded as *caballus*. These species are as follows:—

* The studies and observations on which this paper is based were financed jointly by the South African Institute for Medical Research and the Poliomyelitis Research Foundation.

Aedes (Ochlerotatus) caballus (Theobald) 1912

Aedes (Ochlerotatus) chelli (Edwards) 1915

Aedes (Ochlerotatus) juppi spec. nov.

Recognition of these species brings the total of *Ochlerotatus* species in Africa south of the Sahara to six.

KEY TO SPECIES OF *OCHLEROTATUS* IN AFRICA SOUTH OF THE SAHARA

FEMALES

- | | | |
|---|---|-------------------|
| 1 | Some tarsal segments with basal pale bands | 2 |
| | Tarsi without basal bands | 5 |
| 2 | Lower mesepimeral setae present; proboscis entirely dark | 3 |
| | These setae absent; proboscis pale on basal 0,5 | fryeri |
| 3 | Wing profusely speckled | caballus |
| | Wing almost entirely dark | 4 |
| 4 | Hind tarsus, with pale basal band on tarsomere 3 about as broad as basal band on tarsomere 2, tarsomere 4 with distinct basal pale band | juppi |
| | Hind tarsus, with basal band on tarsomere 3 narrower than band on tarsomere 2, tarsomere 4 entirely dark or indistinctly pale at base | chelli |
| 5 | Wing and proboscis entirely dark | harrisoni |
| | These parts speckled, sometimes sparsely | breedensis |

MALES

- | | | |
|---|--|-------------------|
| 1 | Some tarsal segments with basal pale bands | 2 |
| | Tarsi without basal bands | 5 |
| 2 | Proboscis entirely dark | 3 |
| | Proboscis pale on basal 0,5 | fryeri |
| 3 | Tarsomere 4 of hind tarsus with distinct pale band basally | juppi |
| | Tarsomere 4 entirely dark | 4 |
| 4 | Filament of claspette pigmented, rod-like on basal two-thirds, transparent, blade-like on apical third; wing entirely dark | chelli |
| | Filament a uniformly transparent blade; costa and R1 vein with scattered pale scales on basal 0,5 | caballus |
| 5 | Wing and proboscis entirely dark | harrisoni |
| | These parts speckled, sometimes sparsely | breedensis |

Aedes juppi spec. nov., figs 1-10

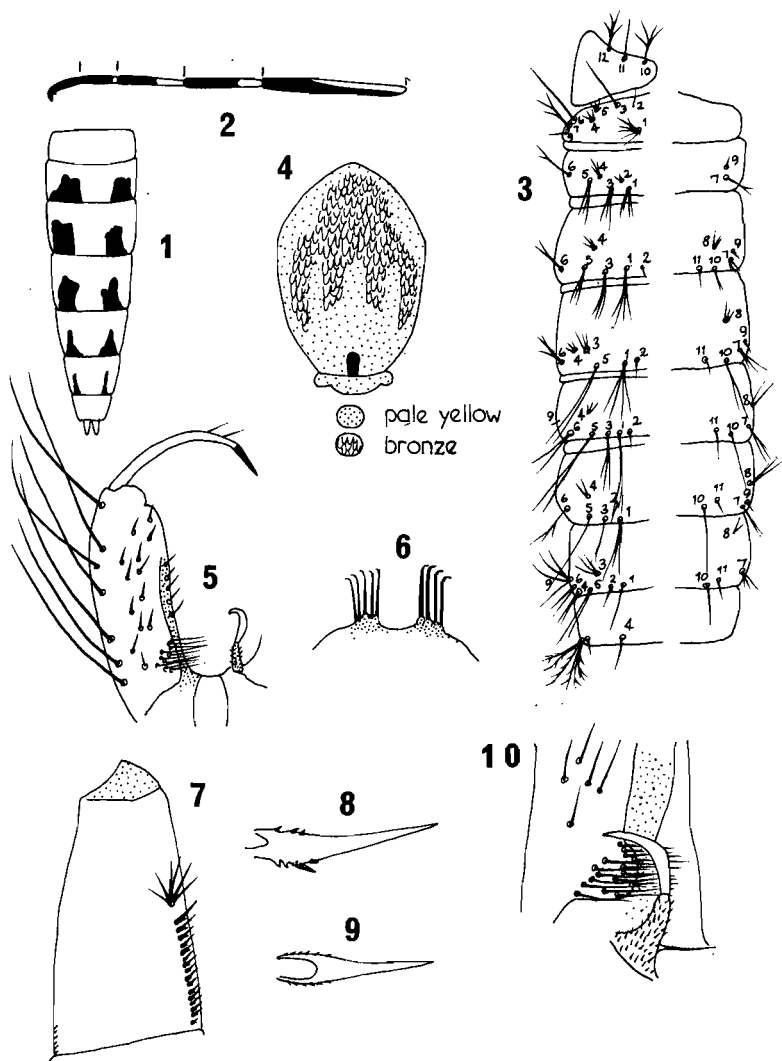
Aedes (Ochlerotatus) caballus Edwards, 1941, Mos. Ethiop. Reg. III: 117 (in part); Muspratt, 1955, J. ent. Soc. sth. Afr. 18: 160 (in part)

FEMALE. *Head:* decumbent scales of vertex narrow, pale yellow mesad, golden or bronze laterad; erect scales largely pale yellow, a few dark laterad; torus with creamy scales dorso-mesad; flagellomere 1 with pale scales; proboscis dark; palpus dark with scattered pale scales, about 0,2 as long as proboscis. *Thorax:* scales on anterior two-thirds of scutum largely dark bronze with variably pale yellow margin, or entirely dark, on posterior third largely pale yellow, with yellow and bronze scales tending to form linear pattern between wing-roots; prescutellar area densely clothed with pale yellow scales, partially obliterating bare space; scutellum with narrow pale yellow scales; paratergite densely clothed with broad creamy scales; ante-pronotum with narrow golden and broad creamy scales; post-pronotum mostly with narrow golden scales, a few broad creamy scales postero-ventrad; propleuron, sub- and post-spiracular

areas, pre-alar knob, mesepisternum, mesepimeron and coxae densely clothed with broad creamy scales; a patch of similar scales on metameron; several lower mesepimeral setae present. *Abdomen*: terga largely pale, with rather irregular-shaped sub-lateral apical dark patches, largest on tergum 2 and decreasing on successive terga; sterna largely creamy with small dark apicolateral spots and baso-median streaks. *Legs*: femora with small creamy knee-spots; femora and tibiae speckled, with dark and creamy scales rather evenly intermixed, except white predominating on basal 0,5 of hind femur and along dorsal margin of mid-tibia; hind tarsus with basal pale marks on tarsomeres 1-4, tarsomere 5 entirely dark, rarely a few pale scales basally; tarsomere 1, of hind tarsus, with pale scaling on about basal 0,75, pale mark tapering distally, tarsomere 2 pale on about basal 0,3, tarsomere 3 pale on about basal 0,4 and with this band about as broad as band on tarsomere 2, tarsomere 4 pale on basal 0,2-0,5; fore and mid-tarsi with similar but less distinct basal pale marks as hind tarsus, that on tarsomere 4 sometimes absent; hindungues equal, unidentate. *Wings*: entirely dark, except line of pale scales on about basal 0,1 of costa on both dorsal and ventral wing surfaces, rarely also a few scattered pale scales at base of R1 on both wing surfaces. Wing 4,1 mm. Proboscis 2,4 mm. Fore femur 1,8 mm.

MALE. Essentially like female. *Head*: palpus, apical 0,5 of shaft and basal 0,5 of segment 4 with light to moderate speckling of pale scales, longer than proboscis by about 0,5 of terminal segment, apical 0,2 of shaft swollen, densely setose with clump of about 120 long, closely-spaced setae, segment 4 with two rows of setae, each row with about 150 setae, segment 5 densely setose. *Thorax*: scutal scales rather uniform in colour, largely pale, pattern not evident; lower mesepimeral setae absent. *Abdomen*: terga 2-6 with pale scales restricted to median basal bands; tergum 7 with scattered pale scales. *Legs*: unguis of fore tarsus unequal, larger unguis with two denticles, smaller unidentate, unguis of mid-tarsus unequal, both unidentate, of hind tarsus sub-equal, both unidentate. *Genitalia*: 9th tergite with prominent pigmented lobes bearing about 5 strong setae with their apices bent outwards; gonocoxite, as wide at apex as base, apical lobe inconspicuous and largely devoid of setae, basomesal lobe not projected, consisting of about 30 closely-spaced setae, spines absent; gonostylus curved, thin and tapering on apical third with spine-like terminal claw; claspette with curved, slightly angular transparent filament, broadened about middle, slightly longer than stem; paraproct with curved apical tooth and about 5 setae. Wing 4,6 mm. Proboscis 3,0 mm. Palpal shaft 2,1 mm, segment 4, 0,7 mm, segment 5, 0,65 mm.

LARVA. *Head*: antenna only slightly curved, barely 0,5 length of head, finely spiculate; seta 1-A 2-4b, simple; setae 5, 6-C single, thick, simple, sub-equal, about 0,3 length of head with 5 placed almost directly behind 6; seta 7-C 3-5b, simple. *Thorax*: seta 1-P single. *Abdomen*: comb with 8-10 sharp-pointed spines, each with a basal fringe of very fine denticles; siphon short, relative siphon length (L/S) (Schick, 1970) 2,4-2,8; pecten with 15-24 (mean 18) spines, evenly and closely-spaced together, pecten row length index (P/L) (Schick, 1970) 0,42-0,50; these spines sometimes slightly curved dorsally, towards base with a few fine denticles dorsally, a single large denticle as well as several smaller ones ventrally; seta 1-S 3-8b (mean 6), simple, length about 0,3 width of siphon, seta 1-S placement index (H/L) (Schick, 1970) 0,52-0,61; saddle incomplete, setae 4-X with 2 setae on unbarred part, about 16 setae on barred part, latter with 6-8 branches.



Figs 1-10. *Aedes juppi* spec. nov. 1. Tergum. 2. Hind tarsus. 3. Pupal chaetotaxy. 4. Scutum. 5. Male genitalia. 6. 9th tergum, male. 7. Larval siphon. 8. Distal pecten spine. 9. Comb spine. 10. Basomesal lobe and claspette in mesal view.

PUPA. Chaetotaxy as shown, fig. 3.

MATERIAL EXAMINED. Holotype, ♀, reared from female M1186E, collected by me in November, 1972, at Onderstepoort, SOUTH AFRICA. Allotype, ♂, reared from same female as holotype. Paratypes, 12 ♀♀, 9 ♂♂, reared in isolation from three females with the same field data as holotype. The holotype, allotype, 13 paratypes deposited at the South African Institute for Medical Research, Johannesburg; two ♀♀ and two ♂♂ paratypes each, deposited at the United States National Museum and the British Museum (Natural History). Material was examined from the following localities. SOUTH AFRICA: *Transvaal*; Onderstepoort (30 ♀, 11 ♂, 15 larvae, 2 pupae, 4 rearings); Bapsfontein (1 ♀), Lake Chrissie (1 ♂), Pretoria (2 ♂), Kroondal (3 ♀, 3 ♂, 9 larvae, 9 pupae, 2 rearings); *Orange Free State*; de Wetsdorp (1 ♂), Vaal River (3 ♀), *Cape*; Worcester (6 ♀, 4 ♂), Swellendam (1 ♀), Ceres (1 ♀), Uitenhage (1 ♀), Mossel Bay (1 ♀), Knysna (1 ♀), Port Alfred (1 ♀), Blauwkrantz (2 ♀), Middelburg (1 ♂), Noupoot (1 ♀), Steynsburg (2 ♀), Hopetown (18 ♀, 3 ♂, 6 larvae, 6 pupae, 4 rearings). LESOTHO: Mamethes (1 ♀). This species is dedicated to Peter G. Jupp in recognition of his work on the mosquitoes of South Africa.

DIAGNOSIS. This is the largest and most distinctive species of the group. In the female it is clearly separable from *caballus* by the dark wing and from *chelli* as well as *caballus* by the well-developed tarsal bands. The latter character also distinguishes it from both these species in the male.

BIONOMICS. From its known distribution, this species is apparently adapted to temperate conditions and is possibly endemic to the temperate regions of southern Africa. Collections suggest that it is probably the dominant species of the group in the Highveld region of the Transvaal and northern Orange Free State and it seems to be the only species in the western and coastal regions of the Cape province. It co-exists with *caballus* over a large area including the Karoo and southern Orange Free State, where its prevalence relative to *caballus* is unknown because of confusion with that species in the past. It is highly anthropophilic, feeds readily on the larger domestic animals and possibly also, to some extent, on birds. It feeds readily during daylight near its resting sites, but its feeding peak is in the early part of the night. The larvae occur in temporary ground pools in grassland. They were difficult to rear in the laboratory and thrived best under subdued light.

DISEASE RELATIONSHIP. Due to confusion with *caballus* (*sensu stricta*) in the past it is now unknown to what extent *juppi* was concerned in the transmission of Rift Valley fever, Wesselsbron and Middelburg viruses previously attributed to *caballus* (*sensu lato*) and mentioned earlier. Since both species occur in the two localities where these viral observations were made, either species or both could have been involved. In a recent laboratory test only one out of 16 *juppi* was infected by feeding on a viraemic hamster circulating 3.8 logs of Rift Valley fever virus. The same female failed to transmit virus at a subsequent feed 10 days-later (unpublished studies).

Aedes caballus (Theobald) figs 11-16.

Grabhamia caballa Theobald, 1912. *Entomologist* **45**: 93; Edwards, 1925, *Bull. ent. Res.* **15**: 261

Aedes* (*Ochlerotatus*) *chelli Edwards, 1924. *Ann. S. Afr. Mus.* **19**: 159 (*nec. O. chelli* Edwards, 1915)

Aedes* (*Ochlerotatus*) *caballus Edwards, 1925. *Bull. ent. Res.* **15**: 270 Edwards, 1941. Mos. Ethiop. Reg. III: 117 (in part) Muspratt, 1955. *J. ent. Soc. sth. Afr.* **18**: 160 (in part).

FEMALE. Similar to *juppi* but with the following differences:— *Head*: fewer dark scales laterad on vertex; palpus sometimes entirely dark. *Thorax*: scutum, with scales uniformly dark bronze on anterior two-thirds, without distinct pattern between wing-roots. *Abdomen*: dark patches on terga larger, more rectangular, median pale band on terga 2, 3 rather narrow; sterna paler. *Legs*: basal 0,5 of hind femur darker, with an even intermixture of dark and pale scales; hind tarsus, with basal pale band on tarsomere 1 consisting largely of speckling, basal band on tarsomere 3 barely 0,2 length of tarsomere and smaller than basal band on tarsomere 2; tarsomere 4 entirely dark, rarely a few pale scales basally; fore and mid-tarsi similar to hind tarsus. *Wing*: extensively speckled with creamy scales as follows:— subcosta entirely, costa and R1 almost to apex, remaining veins lightly to moderately speckled on about basal 0,75, except both forks, R4 + 5 and M3 + 4, mostly or entirely dark; on ventral wing surface costa extensively speckled on basal 0,75. Wing 3,4 – 3,9 mm. Proboscis 2,3 mm. Fore femur 1,6 mm.

MALE. Differences from *juppi* as follows:— palpus slightly less setose; basal pale marks on hind tarsus much reduced, that on tarsomere 2 very small, on 3 barely visible, sometimes absent, 4 entirely dark. *Genitalia*: apical lobe slightly more prominent and more setose; filament of claspette probably less angular and lacking bulge on convex surface; setae of 9th tergal lobe not bent at apex. *Wing*: a few scattered pale scales on basal 0,5 of costa and R1.

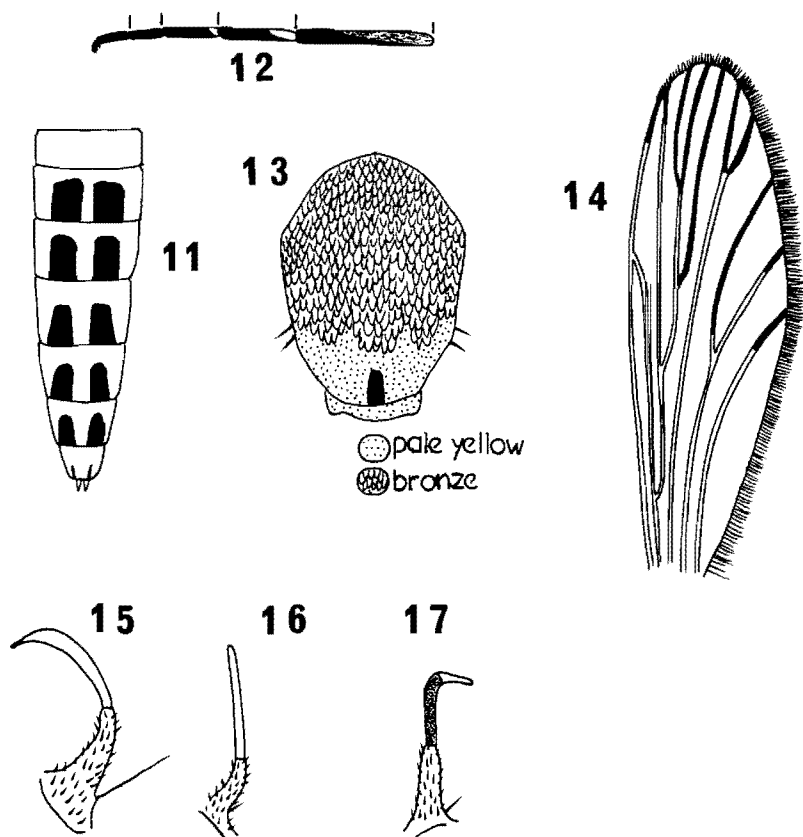
LARVA. Probably no reliable differences from *juppi*. Seta 1–A single or 2b; seta 1–P often 2b; pectin with 14–21 spines (mean 16, hence usually fewer than *juppi*); seta 1–S usually with fewer branches, 3–6 with a mean of 4 (perhaps the most reliable difference); L/S 2,6–2,9; P/L 0,47; H/L 0,57–0,62.

PUPA. No reliable differences from *juppi* observed.

MATERIAL EXAMINED. Holotype, ♀, *Grabhamia caballa*. Locality; Onderstepoort, SOUTH AFRICA. British Museum (Natural History). Material was examined from the following localities:— *Transvaal*; Onderstepoort (15 ♀, 7 ♂, 9 larvae, 5 pupae, 2 rearings), Naboomspruit (6 ♀, 1 ♂, 4 larvae, 1 pupa, 1 rearing). *Orange Free State*; de Wetsdorp (1 ♂), Wesselsbron (1 ♂). *Cape*; Middelburg (1 ♀), Steynsburg (2 ♀), Hopetown (2 ♀, 1 rearing). *Natal*; Weenen (3 ♀, 3 ♂). SOUTH WEST AFRICA. Okakarara (1 ♀). Nomtele (1 ♀).

DIAGNOSIS. In the female the profusely speckled wing reliably separates this species from both *juppi* and *chelli*. In the male, on account of the light speckling of the wing, the poorly developed hind tarsal bands would be necessary to separate it from *juppi*. Separation from male *chelli* might be difficult should the wing be rubbed. In such cases the genitalic differences, if reliable, would have to be used. The filament of the claspette shows an abnormal form in some topotypical specimens as well as in specimens from Naboomspruit. The filament is nearly straight, rod-like, blunt-tipped and this is apparently not due to the orientation of the claspette on the slide.

BIONOMICS. Apparently adapted to higher temperatures and a lower rainfall than *juppi* and in this respect seems close to *chelli*. It seems to be absent from the tropical, coastal regions of northern Natal and Mocambique. Like its congener in South Africa,



Figs 11–17. *Aedes* spp. 11–16. *A. caballus*. 11. Tergum. 12. Hind tarsus. 13. Scutum. 14. Wing (solid veins without pale scales). 15. Claspette. 16. Claspette (abnormal ?). 17. *A. chelli* (from Iran), claspette.

caballus feeds readily on man and the larger domestic animals. In my experience, including collections at Hopetown bordering on the Karoo, it is rarer than *juppi* but this may not be the case over the entire Karoo.

DISEASE RELATIONSHIP. See remarks under *juppi*.

Aedes chelli (Edwards) fig. 17

Ochlerotatus chelli Edwards, 1915, *Bull. ent. Res.* 5: 275

Aedes (Ochlerotatus) caballus Edwards, 1925, *Bull. ent. Res.* 15: 261 (Synonymy). Edwards, 1941, *Mos. Ethiop. Reg.* III: 117 (in part)

FEMALE. Similar to *caballus* but with the following differences: *Thorax*: metameron devoid of scales. *Leg*: tarsomere 4 of all legs indistinctly pale basally. *Wing*: almost entirely dark, pale scales only on basal 0,1 of costa. Wing: 3,5–3,7 mm.

MALE. Differences from *caballus* as follows: *Genitalia*: 9th tergite with lobes less prominent, a few scattered setae on non-pigmented part of tergite; gonostylus thicker on apical third; gonostylar claw relatively shorter and blunter; filament of claspette in two parts, on basal 0,66 pigmented, curved and rod-like, on apical 0,33 a pointed, translucent blade. *Wing*: pale scales, if any, restricted to extreme base of costa.

LARVA. Unknown.

PUPA. Unknown.

MATERIAL EXAMINED. Lectotype, ♀, by present selection a syntype labelled as lectotype. Locality; Dido, near Marsabit, KENYA. Paralectotypes, the two remaining female syntypes, by present selection and labelled as such. The three female syntypes were labelled as cotypes by Edwards, and according to the labels were collected by Dr J. R. H. Chell at Dido, British East Africa, on 30.11.1911. The specimens were presented by the Imperial Bureau of Entomology and bear a British Museum accession number 1914.490. Material was examined from the following localities: KENYA. Dido (3 ♂). SUDAN. Kordofan (1 ♂, genitalia missing). ADEN. Wadi Kaklya (3 ♀). IRAN. Djask (2 ♀, 2 ♂ with mounted genitalia).

DIAGNOSIS. The association of the males from Iran with *chelli* is presumptive as I have not seen males from Kenya. Although, within the limits determined by their poor condition, the females from Iran agree with the syntypes of *chelli* there is some doubt whether the males from Iran are *chelli*. After having seen the above description of males from Iran, Mrs E. C. C. van Someren (*in litt.*) has advised me that there are differences in the filament of the claspette of males from Kenya she has examined. In males from Kenya the filament is not pigmented on the basal two-thirds and, throughout its length, appears as a narrow, evenly curved, translucent blade. However, until further material can be examined it seems advisable to regard the Kenya and Iran specimens as conspecific. The female of *chelli* is easily separable from *caballus* by the dark wing but in the male, because of the scanty scaling in male *caballus*, separation might be difficult, unless the claspette filament described above for *chelli* proves reliable. All the females of *chelli* that I have seen are poor specimens with most of the hind tarsi missing. However, from Edwards' original description of *chelli* and from the tarsi I have examined it is evident that the tarsi of *chelli* are quite different from *juppi* and similar to *caballus*, although it seems that tarsomere 4 of the hind tarsus of *chelli* may regularly be indistinctly pale basally.

According to Mrs van Someren there are three Dido's in Kenya. The type locality of *chelli* is undoubtedly the Dido situated about 60 kilometres north of Marsabit, in the Northern Province. This is where Dr Chell collected (Edwards, 1941) and is the only locality in Kenya from where Mrs van Someren has seen specimens of *chelli*.

BIONOMICS. Apparently rare in Kenya and only collected twice, both in the Marsabit area and probably absent on the Kenya coast (van Someren). Its distribution indicates that it is adapted to arid conditions.

ACKNOWLEDGEMENTS

I am grateful to Dr P. F. Mattingly for lending me specimens from the British Museum (Natural History) and for checking the manuscript, and to Messrs J. A.

Ledger, P. G. Jupp and Mrs E. C. C. van Someren for commenting on the manuscript. For the rearing of mosquitoes I am indebted to Dr Dora Anderson.

REFERENCES

- EDWARDS, F. W. 1925. Mosquito notes.—V. *Bull. ent. Res.* **15**: 257–270.
- EDWARDS, F. W. 1941. Mosquitoes of the Ethiopian Region. III. Culicine Adults and Pupae. British Museum. Natural History. 1–499.
- GEAR, J., DE MEILLON, B., LE ROUX, A. F., KOFSKY, R., ROSE-INNES, R., STEYN, J. J., OLIFF, W. D. & SCHULTZ, K. H. 1955. Rift Valley fever in South Africa. A study of the 1953 outbreak in the Orange Free State, with special reference to vectors and possible reservoir hosts. *S. Afr. med. J.* **29**: 514–518.
- KOKERNOT, R. H., DE MEILLON, B., PATERSON, H. E., HEYMANN, C. S. & SMITHBURN, K. C. 1957. Middelburg virus. A hitherto unknown agent isolated from *Aedes* mosquitoes during an epizootic in sheep in the Eastern Cape Province. *S. Afr. J. med. Sci.* **22**: 145–153.
- KOKERNOT, R. H., PATERSON, H. E. & DE MEILLON, B. 1958. Studies on the transmission of Wesselsbron virus by *Aedes (Ochlerotatus) caballus* (Theo.). *S. Afr. med. J.* **32**: 546–548.
- KOKERNOT, R. H., SMITHBURN, K. C., PATERSON, H. E. & DE MEILLON, B. 1960. Further isolations of Wesselsbron virus from mosquitoes. *S. Afr. med. J.* **34**: 871–874.
- MUSPRATT, J. 1955. Research on South African Culicini. III. A checklist of the species and their distribution, with notes on taxonomy, bionomics and their identification. *J. ent. Soc. sth. Afr.* **18**: 149–207.
- SCHICK, R. X. 1970. Mosquito Studies XX. The Terrens Group of *Aedes (Finlaya)*. *Contr. Amer. Entom. Inst.* **5**: 1–158.

Manuscript received 14 May 1973.